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Original Communication

Alcohol and drugs in suspected impaired drivers in Ontario from 2001 to 2005

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ABSTRACT

Introduction: Blood samples from 733 drivers suspected of driving under the influence of alcohol in the province of Ontario from 2001 to 2005 were retrospectively examined.
Methods: Samples were analyzed for alcohol content by headspace gas chromatography with flame ionization detection. Drivers ranged in age from 15 to 83 years old with the majority of blood samples obtained from males ($n = 623$, 85%). Of the 704 cases where quantifiable numerical values were obtained, blood alcohol concentrations ranged from 13 to 414 mg/100 mL (mean 172 mg/100 mL) for males and 10 to 425 mg/100 mL (mean 173 mg/100 mL) for females. The majority of these drivers ($n = 640/704$, 90.9%) had blood alcohol concentrations of 80 mg/100 mL and greater at the time of sampling. Analysis for alcohol was undertaken in all cases. However, additional toxicological examinations for drugs was conducted on a case-by-case basis based on the submitted case history and/or where there were requests for additional drug analysis, or where such analysis would be probative in the absence of the detection of alcohol at a concentration that could cause impairment.
Results: Therefore, analyses for drugs were only performed in a small subset of 42 cases (6%). Thirty-four of these cases had positive drug findings, with Δ^9-tetrahydrocannabinol being the most frequently encountered drug ($n = 18$), followed by benzoylecgonine/cocaine ($n = 8$), morphine ($n = 6$), lorazepam ($n = 5$) and diphenhydramine ($n = 4$). The majority of individuals were involved in some type of motor vehicle accident ($n = 658$, 89.8%), with single motor vehicle accidents ($n = 412$, 56.2%) being the most common, followed by multiple motor vehicle accidents ($n = 169$, 23%). Injuries ($n = 309$, 42.1%) were the main cause of individuals not being able to provide breath samples with specific, non-life threatening injuries ($n = 178$, 24.3%) representing the highest percentage of cases. The majority of incidents ($n = 449$, 61.3%) occurred between Friday and Sunday reaching a peak on Saturday ($n = 174$, 23.7%). Incidents occurred throughout the day, with the majority of events ($n = 449/705$, 63.7%) for which a time was provided occurring between 6:01 pm and 3:00 am, and the peak number of incidents occurring between 9:01 pm and midnight ($n = 168/705$, 23.8%).
Conclusion: However, these data demonstrate that "drugged driving" does occur and that further, comprehensive investigation is needed to determine the frequency and type of drug use by Ontario drivers.

1. Introduction

The Canadian province of Ontario has a population of over 12 million, with over 8 million licensed drivers and more than 7 million registered motor vehicles.[1] The legal driving age is 16, while the legal drinking age in Ontario is 19 and the legal limit for blood alcohol and driving in Canada is 80 mg/100 mL.

When a police officer has reasonable and probable grounds to believe that a person's ability to operate a motor vehicle may be impaired by alcohol, or that they have a blood alcohol concentration (BAC) in excess of 80 mg/100 mL, that officer may make a demand for a sample of that person's breath for the purpose of determining their BAC. In situations where a police officer believes an individual may be incapable of providing a sample of their breath, or that it would be impractical to obtain a breath sample, the officer may make a demand for a sample of the person's blood, called a '*blood demand*'.

The purpose of this study was to retrospectively examine and present the findings and circumstances from '*blood demand*' cases in Ontario submitted over a 5-year period (2001–2005).

2. Methods

Cases considered for this study were submitted to the Toxicology sections of the Centre of Forensic Sciences (CFS) in Toronto

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and the Northern Regional Laboratory (NRL) in Sault Ste. Marie over a 5-year period between January 1, 2001 and December 31, 2005. Two samples of venous blood were collected in hospital by a qualified medical practitioner into 10 mL grey top tubes (Vacutainer® XF947, BD Vacutainer® 367001, BD Vacutainer™ 367001, Vacutainer® 367001, or BD Vacutainer™ XF947) containing 1% sodium fluoride and 0.5% potassium oxalate added as a preservative and anti-coagulant, respectively. Samples were stored at approximately 4 °C after arrival in the laboratory.

Samples were analyzed using a volatiles screen method that simultaneously detects and quantitates methanol, ethanol, isopropanol, acetone and qualitatively detects the presence of acetaldehyde and n-propanol by headspace gas chromatography equipped with dual columns (DB-624 (J&W Scientific) and Rtx®-BAC2 (Restek Corporation)) and dual flame-ionization detectors using t-butanol as an internal standard.[2] The method has a limit of detection (LOD) of 5 mg/100 mL and limit of quantitation (LOQ) of 10 mg/100 mL with linearity up to 1000 mg/100 mL.

While a '*blood demand*' is issued for the purpose of determining the concentration of alcohol in an individual's blood, it is the practice of our laboratories to conduct further toxicological examinations on a case-by-case basis. The large caseload and heavy demands on laboratory resources prevents full drug screening in every '*blood demand*' case. However, additional analyses for drugs may be performed, if the case history suggests and/or requests drug analysis, or where such analysis would be probative in the absence of the detection of alcohol at a concentration that could cause impairment.

Additional qualitative drug screening, when undertaken, utilized either Enzyme-Linked ImmunoSorbent Assay (ELISA)(Neogen Corporation, Diagnostix Ltd. and Immunanalysis Corporation) for the detection of barbiturates, cocaine metabolite (benzoylecgonine), cannabinoid metabolites, benzodiazepines and opioids (codeine, hydrocodone, morphine, levorphanol and hydromorphone), or a general drug screening procedure capable of detecting over 150 different drugs and their metabolites using gas chromatography with a combination of dual nitrogen–phosphorus detectors and mass spectrometry.[3] Positive drug screen findings were subsequently confirmed and quantitated using a different drug specific method.

3. Results

There were 733 cases submitted to our laboratories during the study period. Males (n = 623, 85%) represented the largest percentage of drivers in this study (Table 1). Male drivers ranged in age from 16 to 83 years old (mean 36 years old) while female drivers ranged in age from 15 to 72 years old (mean 35 years old). Male drivers between 20 and 29 years old (n = 196, 31.6%) represented the largest group of males observed in this study, while the highest percentage of female drivers were between 30 and 39 years old (n = 35, 31.8%). The age of two male drivers was not provided.

Table 1
Driver statistics.

Age	# of males	# of females
15	0	1
16–18	24	6
19	31	2
20–29	196	30
30–39	137	35
40–49	135	26
50–59	62	7
60–69	23	1
70–79	10	2
80–89	3	0
Unknown	2	0
Total	623	110

Table 2
Blood alcohol concentration (BAC) data for drivers.

BAC mg/100 mL	# of males	# of females
ND (<5)	20	5
Traces (5–9.9)	4	0
10–49	22	1
50–79	32	9
80–99	31	8
100–149	138	28
150–199	179	26
200–249	120	16
250–299	53	11
300–349	18	4
350–399	4	1
400–449	2	1

Alcohol was not detected (ND) in 25 cases, while the majority of cases (n = 708, 96.6%) were positive for alcohol (Table 2). Of the cases (n = 704, 96%) where quantifiable numerical values were obtained, BACs ranged from 13 to 414 mg/100 mL (mean 172 mg/100 mL) for males and 10 to 425 mg/100 mL (mean 173 mg/100 mL) for females. The majority of male (n = 545/623, 87.5%) and female (n = 95/110, 86.4%) drivers had BACs of 80 mg/100 mL and greater at the time of sample collection. The BAC range with the highest percentage of male drivers was between 150 and 199 mg/100 mL (n = 179/623, 28.7%), while the BAC range with the most female drivers was between 100 and 149 mg/100 mL (n = 28/110, 25.4%).

Cases were classified according to the circumstances involved and are presented in Fig. 1. The majority of drivers were involved in motor vehicle accidents (n = 658, 89.8%), with single motor vehicle accidents (SMVA) having the highest frequency (n = 412, 56.2%) of occurrence. Multiple motor vehicle accidents (MMVA) accounted for the next largest percentage of incidents (n = 169, 23.1%). There was a further category of Unknown motor vehicle accidents (UMVAs) (n = 77, 10.5%) where some type of accident occurred, but no other information was available to assist further classification as either an SMVA or MMVA. SMVAs were defined as those where the driver's vehicle was the sole vehicle involved in the accident and included collision with a fixed object such as a tree, parked motor vehicle, or utility pole, or their vehicle left the roadway due to objects appearing on the road, road conditions, or an inability to correctly navigate the road. MMVAs were defined as any type of collision with another motor vehicle in traffic. Non-MVA incidents (n = 70, 9.5%) had the lowest frequency of occurrence, and were defined as those where the driver was stopped by a police officer during a routine safety check, for a highway traffic act infraction, erratic driving, or during a roadside impaired driving spot check. Four cases in this category involved drivers

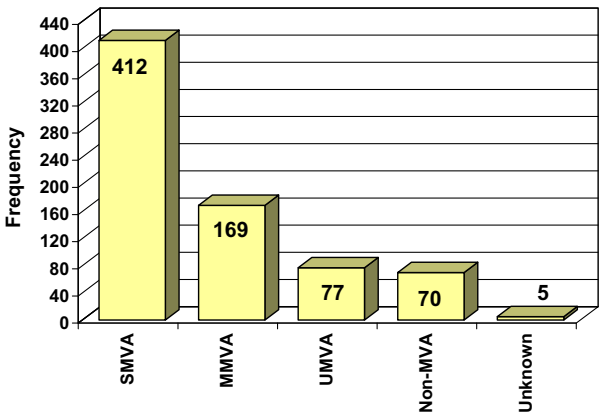

Fig. 1. Incident circumstances. SMVA = single motor vehicle accident; MMVA = multiple motor vehicle accident; UMVA = unknown motor vehicle accident.

who were found by police passed out, unconscious, or sleeping in the driver's seat of their vehicle in traffic with the engine running. No accidents had occurred in these cases, and the BACs of this subgroup ranged from 191 to 435 mg/100 mL (mean 293 mg/100 mL). Five cases (0.7%) were classified as 'Unknown' as the provided case histories did not permit categorization into a specific type of incident.

Injuries (n = 309, 42.2%) were the main reason for drivers not being able to provide breath samples when requested to do so with specific, non-life threatening injuries representing the highest percentage (n = 178, 24.3%) of cases. A summary of reasons taken from the case histories as to why a driver could not provide a breath sample are listed in Table 3. Ten drivers were able to successfully provide a breath sample into the Draëger Alcotest 7410 GLC approved screening device and registered a "Fail" message, indicating that their BAC was 100 mg/100 mL or greater; however these individuals were subsequently unable to provide a breath sample into an approved breath testing instrument when requested to do so. In two other cases, drivers were able to provide only a single breath sample into an Intoxilyzer® 5000C, before developing a medical condition which prohibited the provision of a second sample. Since the recommendation for breath testing in Canada is to obtain at least two breath samples, it was therefore necessary in these cases to subsequently collect blood samples for analysis.

The majority of incidents (n = 449, 61.3%) occurred between Friday and Sunday as shown in Fig. 2, with the most cases occurring on Saturday (n = 174, 23.7%). Incidents occurred throughout the day, with the peak incidents occurring in the evening between 9:01 pm and midnight (n = 168, 23.8%) and the majority of incidents occurring between 6:01 pm and 3:00 am (n = 449, 63.7%) (Fig. 3). No incident time was provided for 28 cases. In the cases where times were given, the time elapsed between the incident and blood sample collection in each case ranged from 37 min to 7 h (mean 2 h 23 min).

Table 3
Case submission history related to why a breath sample could not be provided.

Reasons for inability to provide a breath sample	No. (%)
Specific medical injuries	178 (24.3%)
Non-specific medical injuries	131 (17.9%)
Physician determined that subject cannot provide sample	49 (6.7%)
Pre-existing medical condition	21 (2.9%)
Developed medical condition	19 (2.6%)
Respiratory difficulties	18 (2.5%)
Attempts made but unsuccessful	8 (1.1%)
Subject loses consciousness	7 (1.0%)
Breath testing instrument not working/available	3 (0.41%)
No explanation given in case history	299 (40.1%)

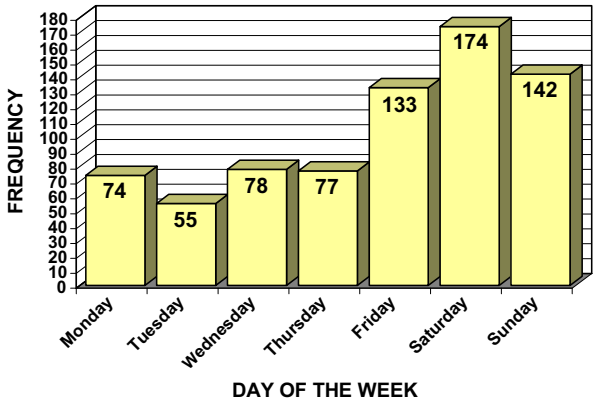

Fig. 2. Day of the week that incidents occurred.

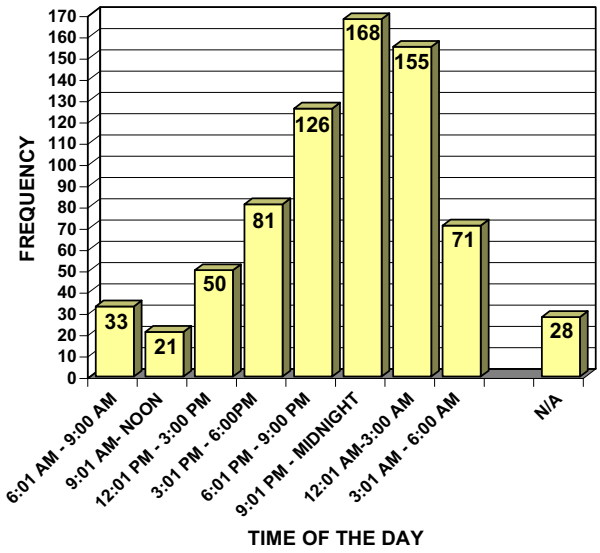

Fig. 3. Time period the incidents occurred.

Table 4A
Incidence of multiple drug findings in suspected impaired drivers.

No. of drugs detected	Alcohol detected	Alcohol not detected
No drugs detected	7	1
One drug detected	9	9
Two drugs detected	6	7
Three drugs detected	2	1
Total	18	24

In the majority of cases (n = 691, 94%), alcohol was the only analysis performed. In 16 cases (2%) samples were analyzed for alcohol and one other specified drug and in 26 cases (4%) more extensive analyses were performed, including general screening for pharmaceuticals and drugs of abuse. Of the aforementioned 42 cases where other toxicological analyses were undertaken, 34 (n = 29 male; n = 5 female) had positive drug findings, the results of which are summarized in Tables 4A and 4B. The drugs most frequently detected were: Δ^9-tetrahydrocannabinol (n = 18), benzoylecgonine/cocaine (n = 8), morphine (n = 6), lorazepam (n = 5) and diphenhydramine (n = 4). For the eight cases where additional analyses were undertaken and no drug findings were detected, one case also had no alcohol detected, while seven were alcohol

Table 4B
Incidence of specific drug findings in suspected impaired drivers.

Drug	Alcohol detected	Alcohol not detected	Concentration range
THC	7	11	<1–10 ng/mL
Benzoylecgonine	6	2	0.13–6.3 mg/L
Cocaine	4	2	<0.13–0.29 mg/L
Morphine	3	3	<15–101 ng/mL
Lorazepam	2	3	10–501 ng/mL
Oxycodone	1	2	<0.032–0.11 mg/L
Diphenhydramine	1	3	<0.13 mg/L
Citalopram	2	0	<0.13–0.2 mg/L
Nordiazepam	0	3	0.10–2.2 mg/L
Diazepam	0	2	0.70–1.3 mg/L
MDMA	2	0	0.30–0.40 mg/L
Methadone	0	1	<0.13 mg/L
Dextromethorphan	0	1	<0.13 mg/L
Pseudoephedrine	0	1	0.81 mg/L

positive with BACs ranging from 15 to 280 mg/100 mL (mean 96 mg/100 mL; median 88 mg/100 mL). The BACs for the 17 cases that were drug positive and alcohol positive ranged from 10 to 161 mg/100 mL (mean 88 mg/100 mL; median 95 mg/100 mL), while the number of drug positive cases that had quantified BACs below 80 mg/100 mL was 7.

4. Discussion

In this study of "*blood demand*" cases, the age and gender distribution along with the BAC ranges observed are typical of those reported in other impaired driving studies also investigating results from blood samples.[4–8] The majority of drivers (n = 640/733, 87.3%) had a blood alcohol concentration greater than the legal limit (80 mg/100 mL) at the time of sample collection, while 64 drivers had BACs between 10 and 79 mg/100 mL. The detected BACs represent the concentration at the time the sample was collected. The time between incident and sample collection for these 64 cases ranged from 59 min to 6 h 33 min (mean 2 h 30 min), therefore the BAC may have been higher at the time of the incident due to the elimination of alcohol during the interval.

Two categories of drivers examined in further detail are those below the legal drinking age and those with exceptionally high BACs. As per Table 1, there were 31 (4.2%) drivers who were below the legal drinking age of 19 and yet had positive BACs ranging from 33 to 218 mg/100 mL (mean 126 mg/100 mL). This included a 15-year old female who, in addition to being below the legal drinking age, was also below the legal driving age and yet had a BAC of 121 mg/100 mL. Of the 30 drivers who were legally entitled to drive, 27 (90%) had BACs in excess of the legal limit. Of the 33 (4.5%) drivers who were of legal drinking age (19 years old) at the time of the incident, 27 (81.8%) had BACs in excess of 80 mg/100 mL. Individuals in this age range (16–19 years old) may have less driving experience, exhibit a higher incidence of risk taking, and have less experience with alcohol than their older counterparts.[9,10] Traffic collisions accounted for 34% of the deaths among this same age group in 2004,[11] with 37.2% of these drivers being killed in alcohol related collisions.[12] All the drivers in the under 18-age category in our study were involved in some type of motor vehicle accident, except for a lone driver who was involved in a non-MVA involving the police.

There were 30 (male, n = 24; female, n = 6) drivers who had BACs of 300 mg/100 mL and greater at the time of sampling. Thus, these individuals have developed some level of tolerance to the gross effects of alcohol and would be classified as alcohol dependent.[13] Male drivers in this category ranged in age from 21 to 64 years old (mean 44 years old), while female drivers ranged from 24 to 59 years old (mean 37 years old). BACs for the male drivers in this category ranged from 300 to 414 mg/100 mL (mean 333 mg/100 mL) and from 307 to 425 mg/100 mL (mean 355 mg/100 mL) for female drivers. These high BACs in living individuals exemplify the tolerance that can be acquired to the effects of alcohol, since BACs greater than 300 mg/100 mL can cause death in some individuals.[14–19] The highest BAC measured was 425 mg/100 mL, which was detected in a 24-year old female, who was one four individuals who were found passed out behind the wheel of their motor vehicle whilst in traffic. Twenty-four of these drivers (80%) were involved in some type of motor vehicle accident, while the remaining six were in non-MVAs involving the police. The distribution of incidents in this driver category are dispersed throughout the days of the week in a manner similar to all the drivers and therefore do not appear to be a specific temporal subpopulation of drinking drivers. However, the peak time for incidents involving these drivers was not between 9:01 pm and 12:00 am, as observed in the overall population in this study, but between 3:01 pm and 6:00 pm (n = 7; 23.3%) with the majority of incidents (n = 16; 53%) occurring between 9:01 am and 6:00 pm. Similar temporal trends were observed in studies involving drivers with high BACs in Sweden[20] and Toronto.[21]

There are two possible explanations for those instances (n = 299) where there was no explanation and no additional information available regarding the specific circumstances requiring the '*blood demand*' over the collection of a breath sample. An inability to collect breath samples may be due to a lack of availability of portable approved evidentiary breath testing instruments for testing in a given area or, the fact that some hospital environments may not be conducive to the set-up and operation of the instrument.

Additional toxicological examinations for drugs were conducted on a case-by-case basis based on the submitted case history and/or where there were requests for drugs analyses, or where such analysis would be probative in the absence of the detection of alcohol at a concentration that could cause impairment.

Based on the above criteria, only a small subset of 42 cases (6%) underwent additional toxicological testing with 34 drivers having positive drug findings. A wide range of over-the-counter, prescription and illicit drugs were observed in this study and represent cases where drug impairment may exist in addition to impairment by the presence of alcohol. The 34 drivers in this subgroup represent a younger age range (19–56 years old) when compared to the overall age range of all drivers in this study (15–89 years old).

As in other studies examining alcohol and drug findings associated with blood analysis cases,[4–6] THC was the most common drug detected, with seven cases where THC was found in combination with alcohol, and 11 cases where THC was detected in the absence of alcohol.

There were a total of six cases where morphine was detected, although it was not possible to determine whether the morphine arose from the administration of morphine, heroin or codeine in these cases. There were no amphetamine and methamphetamine positive cases in our study, despite the fact that these drugs have been reported in the 'drugged-driving' literature.[4–6] The absence of their detection in the cases presented herein, however, does not necessarily reflect a true absence, since analysis for these drugs was not undertaken in all 42 cases.

Of the cases in this study with drugs detected, three drug findings stand out and will be examined in further detail. In the first case, 501 ng/mL of lorazepam was detected in a 49-year old male driver involved a MMVA with no alcohol detected. The lorazepam concentration is in excess of the highest reported therapeutic range[22] and is suggestive of significant central nervous system tolerance to the sedating effects of this drug, since this concentration is within a range associated with severe toxicity.[23] In the second case, 0.11 mg/L of oxycodone, 4 ng/mL of THC and no alcohol were detected in a 41-year old male driver involved in a UMVA. The detected oxycodone concentration is in excess of that typically associated with therapeutic use and could be toxic or fatal to an individual who is not tolerant to the central nervous system depressing effects of this drug.[24] The third case involved a 23-year old male driver engaged in a UMVA and was found to have 6.3 mg/L of benzoylecgonine, traces (<0.125 mg/L) of cocaine, traces (<1 ng/mL) of THC and 83 mg/100 mL of alcohol in his blood. The detected benzoylecgonine concentration is in a range associated with deaths attributed to cocaine intoxication[25] or binge use.[26] It is important to note that the cocaine concentration may have been greater at the time of the incident, since it is well documented that cocaine breaks down both *in vivo* and *in vitro* to benzoylecgonine.[27,28]

5. Conclusions

The findings reported herein represent an examination of blood samples from impaired drivers in Ontario from 2001 to 2005 where a demand for blood was made by a police officer. More males than females were determined to be involved in cases where a blood sample was collected and a resultant BAC was detected. Of 733 drivers, 96.5% ($n = 708$) were alcohol positive, and of these, 90.4% ($n = 640/708$) had a BAC $\geqslant$ 80 mg/100 mL, the legal limit in Canada.

The ability of the investigating officers to form *reasonable and probable grounds* to arrest suspected impaired drivers using the tools they have available such as observable signs of intoxication, indicia of impairment during observation of driving, and/or a "Fail" message on an approved screening device correlates well with the high number of alcohol positive drivers over 80 mg/100 mL (640/733, 87.3%) that lead to the *blood demand* for alcohol.

While the '*blood demand*' is issued for the purpose of determining the concentration of alcohol in an individual's blood, due the large caseload and heavy demand on laboratory resources, additional toxicological examination for drugs were done on a case-by-case basis. Specifically, if the case history suggests and/or requests drug analyses, or where such analysis would be probative in the absence of the detection of alcohol at a concentration that could cause impairment, drug analyses may be performed. Therefore, analysis for drugs, other than alcohol, was only performed in a small subset of drivers. These analyses demonstrated that THC, benzoylecgonine/cocaine, and morphine were the most frequently encountered drugs. The small sample size of drivers ($n = 42$, 6% of cases) screened for drugs in this study limits our ability to interpret the relative incidence of alcohol and drug use in suspected impaired drivers. However, these data demonstrate that "drugged driving" does occur and that further, comprehensive investigation is needed to determine the frequency and type of drug use by Ontario drivers.

Conflicts of Interest

None declared.

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None declared.

Ethical Approval

None declared.

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